4.1 Air Surveillance

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Atmospheric releases of radioactive material from the Hanford Site to the surrounding region are a potential source of human exposure. Radioactive constituents in air are monitored at a number of locations on and around the site. The influence of Hanford emissions on the local environment was evaluated by comparing air concentrations measured at distant locations within the region to concentrations measured onsite and at the site perimeter. This section discusses sample collection techniques and analytes tested for at each air sampling location and summarizes the analytical results. A complete listing of all analytical results summarized in this section is reported separately (PNNL-13487, APP. 1). Detailed descriptions of all routine radiological sampling and analytical techniques are provided in the environmental monitoring plan (DOE/RL-91-50). Data from air samples collected during and after a wildfire on the Hanford Site in June 2000 are included in this sections annual data summaries. In addition, air sampling results related to the wildfire are discussed separately in Section 5.0.

4.1.1 Collection of Air Samples and Analytes Tested

Airborne radionuclide samples were collected at 45 continuously operating samplers: 24 on the Hanford Site, 11 near the site perimeter, 8 in nearby communities, and 2 in distant communities (Figure 4.1.1 and Table 4.1.1). Nine of the stations were community-operated environmental surveillance stations (discussed in Section 8.4) that were managed and operated by local school teachers (under contract with Pacific Northwest National Laboratory) as part of an ongoing DOE-sponsored program to promote public awareness of Hanford Site environmental monitoring programs. Air samplers on the Hanford Site were located primarily around major operational areas to maximize the ability to detect radiological contaminants resulting from site operations. Perimeter samplers were located around the site, with emphasis on the prevailing downwind directions to the south and east of the site (discussed in Section 8.1). Continuous samplers located in Benton City, Kennewick, Mattawa, Othello, Pasco, and Richland provided data for the nearest population centers. Samplers in the distant communities of Toppenish and Yakima provided background data for communities essentially unaffected by Hanford Site operations.

Samples were collected according to a schedule established before the monitoring year (PNNL-13109). The air sampling locations and the analytes tested for at each location are given in Table 4.1.1. Airborne particles were sampled at each of these locations by continuously drawing air through a high efficiency glass-fiber filter. The samples were transported to an analytical laboratory and stored for at least 72 hours. The storage period was necessary to allow for the decay of short-lived, naturally occurring radionuclides (e.g., radon gas decay products) that would otherwise obscure detection of longer-lived radionuclides potentially present from Hanford Site emissions. The filters were then analyzed for gross beta radioactivity, and most filters were also analyzed for gross alpha radioactivity.

For most radionuclides, the amount of radioactive material collected on the filter during the 2-week

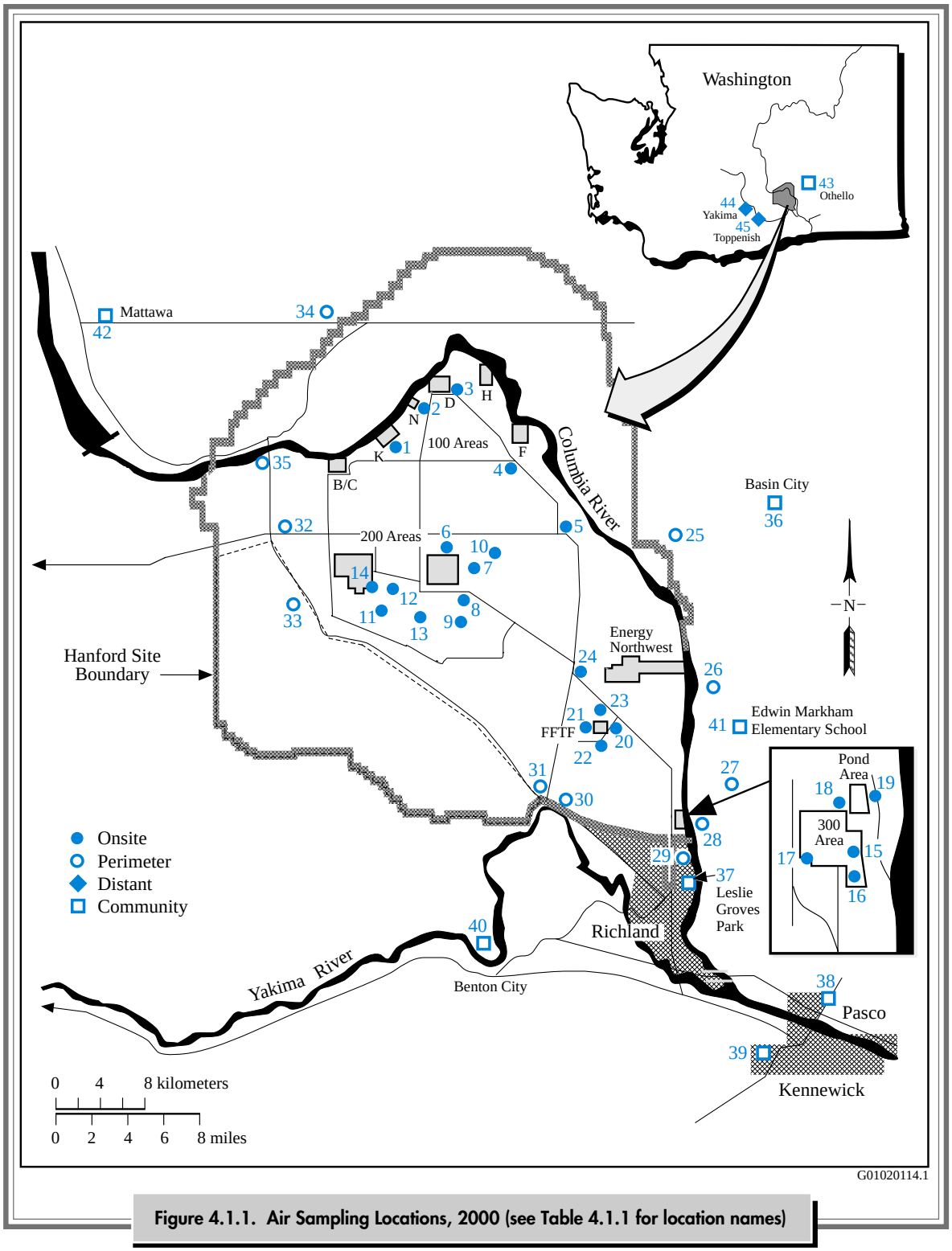

Figure 4.1.1. Air Sampling Locations, 2000 (see Table 4.1.1 for location names)

Table 4.1.1. Air Sampling Locations, Sample Composite Groups, and Analytes, 2000

Map Location[a]	Sampling Location	Analytes[b]	Composite Group	Analytes[c]
Onsite				
1	100 K Area	Alpha, Beta, ^{3}H	100 Areas	Gamma, Sr, Pu
2	100 N-1325 Crib	Alpha, Beta, ^{3}H		
3	100 D Area	Alpha, Beta		
4	100 F Met Tower	Alpha, Beta	Hanford Townsite	Gamma, Sr, Pu
5	Hanford Townsite	Alpha, Beta		
6	N of 200 E	Beta	N of 200 E	Gamma
7	E of 200 E	Alpha, Beta	200 E Area	Gamma, Sr, Pu, U
8	200 ESE	Alpha, Beta, ^{3}H, ^{129}I		
9	S of 200 E	Alpha, Beta		
10	B Pond	Alpha, Beta	B Pond	Gamma, Sr, Pu, U
11	Army Loop Camp	Alpha, Beta	200 W South East	Gamma, Sr, Pu, U
12	200 Tel. Exchange	Alpha, Beta, ^{3}H		
13	SW of B/C Crib	Alpha, Beta		
14	200 W SE	Alpha, Beta	200 West	Gamma, Sr, Pu, U
15	300 Water Intake	Alpha, Beta, ^{3}H	300 Area	Gamma, Sr, Pu, U
16	300 South Gate	Alpha, Beta, ^{3}H		
17	300 South West	Alpha, Beta, ^{3}H		
18	300 Trench	Alpha, Beta, ^{3}H	300 NE	Gamma, Sr, Pu, U
19	300 NE	Alpha, Beta, ^{3}H		
20	400 E	Alpha, Beta, ^{3}H	400 Area	Gamma, Sr, Pu
21	400 W	Alpha, Beta		
22	400 S	Alpha, Beta		
23	400 N	Alpha, Beta		
24	Wye Barricade	Alpha, Beta	Wye Barricade	Gamma, Sr, Pu, U
Perimeter				
25	Ringold Met Tower	Alpha, Beta, ^{3}H, ^{129}I	Ringold Met Tower	Gamma, Sr, Pu
26	W End of Fir Road	Alpha, Beta	W End of Fir Road	Gamma, Sr, Pu, U
27	Dogwood Met Tower	Alpha, Beta, ^{3}H	Dogwood Met Tower	Gamma, Sr, Pu, U
28	Byers Landing	Alpha, Beta, ^{3}H, ^{129}I	Byers Landing	Gamma, Sr, Pu, U
29	Battelle Complex	Beta	Battelle Complex	Gamma
30	Horn Rapids Substation	Alpha, Beta	Prosser Barricade	Gamma, Sr, Pu, U
31	Prosser Barricade	^{3}H		
32	Yakima Barricade	Alpha, Beta	Yakima Barricade	Gamma, Sr, Pu
33	Rattlesnake Springs	Alpha, Beta		
34	Wahluke Slope	Alpha, Beta, ^{3}H	Wahluke Slope	Gamma, Sr, Pu
35	S End Vernita Bridge	Alpha, Beta		

Table 4.1.1. (contd)

Map Location[a]	Sampling Location	Analytes[b]	Composite Group	Analytes[c]
Nearby Communities				
36	Basin City School[d]	Alpha, Beta, ^{3}H	Basin City School	Gamma, Sr, Pu, U
37	Leslie Groves-Rchlnd[d]	Alpha, Beta, ^{3}H	Leslie Groves-Rchlnd	Gamma, Sr, Pu, U
38	Pasco[d]	Beta	Tri-Cities	Gamma, Sr, Pu
39	Kennewick[d]	Alpha, Beta		
40	Benton City[d]	Beta	Benton City	Gamma
41	Edwin Markham School[d]	Alpha, Beta, ^{3}H	Edwin Markham School	Gamma, Sr, Pu, U
42	Mattawa[d]	Beta	Mattawa	Gamma
43	Othello[d]	Beta	Othello	Gamma
Distant Communities				
44	Yakima	Alpha, Beta, ^{3}H, ^{129}I	Yakima	Gamma, Sr, Pu, U
45	Toppenish[d]	Alpha, Beta, ^{3}H	Toppenish	Gamma, Sr, Pu, U

(a) See Figure 4.1.1.
(b) Alpha (gross) and beta (gross) samples are collected and analyzed every 2 weeks, ^{3}H samples are collected and analyzed every 4 weeks, and ^{129}I samples are collected every 4 weeks, combined into a quarterly composite sample and analyzed for each location.
(c) Gamma spectroscopy, strontium-90, isotopic plutonium (^{238}Pu, $^{239/240}Pu$), and isotopic uranium (^{234}U, ^{235}U, ^{238}U) analyses are performed on quarterly composite samples.
(d) A community-operated environmental surveillance station.

period was too small to be readily measured. The sensitivity and accuracy of sample results were increased by combining biweekly samples for nearby locations (or, in some cases, a single location) into quarterly composite samples. The quarterly composite samples were analyzed for specific gamma-emitting radionuclides (see Appendix F), strontium-90, and plutonium isotopes, with selected composites also analyzed for uranium isotopes.

Samples were collected for iodine-129 analysis at four locations by drawing air through a cartridge containing chemically treated, special, low-background petroleum-charcoal positioned downstream of a particle filter. Samples were collected monthly and combined to form quarterly composite samples for each location.

Atmospheric water vapor was collected for tritium analysis at 20 locations by continuously passing air through cartridges containing silica gel, which were exchanged every 4 weeks. The collection efficiency of the silica gel adsorbent is discussed in Patton et al. (1997). The collected water was distilled from the silica gel and analyzed for its tritium content.

The samples collected at the community-operated environmental surveillance stations were submitted to the analytical laboratory and treated the same as all other submitted samples.

4.1.2 Radiological Results for Air Samples

Radiological air sampling results for onsite, site perimeter, nearby communities, and distant communities for gross alpha, gross beta, and specific radionuclides are summarized in Table 4.1.2.

A detectable value is defined in this section as a value reported above the minimum detectable level or above the 2-sigma total propagated analytical uncertainty. A gamma-emitting radionuclide is detectable if the radionuclide library of the software determines an isotope concentration above the minimum detectable concentration of a sample. The nominal detection limit is defined as the average 2-sigma total propagated analytical uncertainty of the population of reported values.

For calendar year 2000, the average gross alpha radioactivity concentrations at the site perimeter were comparable to the levels measured at distant stations (see Table 4.1.2), indicating that the observed levels were predominantly a result of natural sources and worldwide radioactive fallout. The 2000 gross alpha average concentration values were similar to values reported for 1995 through 1999 (see Figure 4.1.2). The highest onsite gross alpha concentration was at the 100 D Area sampling location (3 on Figure 4.1.1).

Gross beta concentrations in air for 2000 (Figure 4.1.3) peaked during the winter, repeating a pattern of natural annual radioactivity fluctuations (Eisenbud 1987). The average gross beta concentration was slightly higher at the site perimeter than the annual average concentration value at the distant location; however, the difference was not statistically significant (log transformed, two-tailed t-test, 5% significance level). The 2000 average values were similar to the average values reported for 1995 through 1999 (see Table 4.1.2).

Tritium concentrations measured in 2000 (excluding 300 Area samples) were similar to values reported for 1995 through 1999 (see Table 4.1.2 and Figure 4.1.4). For 2000, ~73% of the samples analyzed for tritium had results reported above the detection limit (the method is capable of detecting concentrations of no less than 3 pCi/m^3). Sample results above the detection limit were consistently determined for the 300 Area samples. Tritium releases in the 300 Area are associated with research and development activities (see Table 3.1.1). These research and development activities are expected to continue for the next year; therefore, elevated tritium concentrations are expected for the 300 Area samples in 2001 as well. Figure 4.1.4 shows the slightly elevated 300 Area average tritium concentration with respect to other onsite average tritium concentrations, as well as perimeter and distant locations.

The annual average tritium concentration measured at the site perimeter (2.2 ± 0.7 pCi/m^3) appeared to be slightly higher than the annual average value at the distant locations (1.4 ± 0.56 pCi/m^3); however, the difference was not statistically significant (log transformed, two-tailed t-test, 5% significance level). The annual average tritium concentration measured at the site perimeter in 2000 was less than 0.002% of the 100,000-pCi/m^3 DOE derived concentration guide (DOE Order 5400.5).

For samples analyzed for strontium-90 in 2000 (Figure 4.1.5), 13 of the 92 samples were above the detection limit (see Table 4.1.2). The perimeter average is similar to the distant concentrations. The highest level (330 ± 130 aCi/m^3) was determined for the 200 West composite sample (location 14 on Figure 4.1.1), which is 0.004% of the 9 million-aCi/m^3 derived concentration guide. For comparison purposes, there are 1 million attocuries (aCi) in 1 picocurie (pCi).

Iodine-129 analyses were performed on samples collected downwind of the Plutonium-Uranium

Table 4.1.2. Airborne Radionuclide Concentrations in the Hanford Environs, 2000 Compared to Previous Years

		2000				1995-1999				
Radionuclide	Location Group[a]	No. of Samples	No. of Detections[b]	Maximum[c]	Average[d]	No. of Samples	No. of Detections[b]	Maximum[c]	Average[d]	Derived Concentration Guide[e]
				pCi/m^3	pCi/m^3			pCi/m^3	pCi/m^3	pCi/m^3
Tritium	300 Area	75	69	23 ± 2.1	3.8 ± 1.0	265	149	25 ± 3.0	2.4 ± 0.35	100,000
	Onsite	63	47	7.4 ± 1.4	2.0 ± 0.35	317	134	24 ± 20	1.4 ± 0.22	
	Perimeter	64	38	12 ± 1.5	2.2 ± 0.70	315	101	24 ± 2.3	1.3 ± 0.25	
	Nearby communities	36	27	15 ± 1.3	3.2 ± 1.2	191	64	16 ± 15	1.6 ± 0.37	
	Distant communities	25	10	6.1 ± 1.0	1.4 ± 0.56	141	30	7.9 ± 1.1	0.89 ± 0.21	
Gross beta	Onsite	617	611	0.084 ± 0.014	0.016 ± 0.00092	2,617	2,615	0.070 ± 0.0073	0.016 ± 0.00035	No standard
	Perimeter	261	261	0.070 ± 0.011	0.015 ± 0.0012	1,069	1,067	0.098 ± 0.010	0.016 ± 0.00057	
	Nearby communities	210	209	0.053 ± 0.0088	0.016 ± 0.0013	1,038	1,038	0.062 ± 0.0062	0.016 ± 0.00051	
	Distant communities	59	59	0.059 ± 0.010	0.017 ± 0.0027	294	293	0.061 ± 0.0064	0.014 ± 0.0010	
				aCi/m^3[f]	aCi/m^3[f]			aCi/m^3[f]	aCi/m^3[f]	aCi/m^3[f]
Gross alpha	Onsite	591	469	3,500 ± 1,500	750 ± 41	2,391	1,775	5,500 ± 1,300	580 ± 16	No standard
	Perimeter	261	211	2,500 ± 900	710 ± 51	952	764	2,600 ± 1,200	600 ± 23	
	Nearby communities	115	91	2,600 ± 990	870 ± 100	537	418	2,000 ± 760	580 ± 28	
	Distant communities[g]	58	43	2,500 ± 1,200	800 ± 140	294	204	2,300 ± 100	480 ± 44	
Strontium-90	Onsite	40	8	330 ± 130	27 ± 19	83	32	300 ± 96	38 ± 14	9,000,000
	Perimeter	28	2	66 ± 27	5.9 ± 10	56	14	390 ± 79	25 ± 15	
	Nearby communities	16	3	140 ± 83	29 ± 25	32	6	210 ± 190	24 ± 18	
	Distant communities	8	0	63 ± 67	5.5 ± 33	17	2	79 ± 37	10 ± 18	
Iodine-129	Onsite	4	4	26 ± 2.4	20 ± 4.0	20	20	50 ± 12	29 ± 5.0	70,000,000
	Perimeter	8	8	1.2 ± 0.14	0.60 ± 0.32	40	40	2.3 ± 0.28	0.88 ± 0.16	
	Distant communities	4	4	0.22 ± 0.015	0.091 ± 0.088	20	20	0.088 ± 0.056	0.047 ± 0.010	
Plutonium-238	Onsite	40	0	0.89 ± 2.7	-0.17 ± 0.13	83	5	2.9 ± 5.8	-0.021 ± 0.12	30,000
	Perimeter	28	0	0.94 ± 1.4	-0.19 ± 0.15	56	1	1.9 ± 1.4	-0.013 ± 0.10	
	Nearby communities	16	0	1.5 ± 1.8	-0.19 ± 0.33	32	1	0.76 ± 1.3	-0.044 ± 0.15	
	Distant communities	8	0	0.31 ± 1.8	-0.43 ± 0.30	17	0	0.17 ± 1.2	-0.17 ± 0.12	
Plutonium-239/240	Onsite	40	14	6.4 ± 3.7	0.86 ± 0.49	83	35	12 ± 2.5	1.1 ± 0.46	20,000
	Perimeter	28	3	4.3 ± 2.0	0.48 ± 0.38	56	14	4.1 ± 3.3	0.49 ± 0.19	
	Nearby communities	16	1	1.7 ± 2.3	0.44 ± 0.30	32	7	1.3 ± 1.6	0.35 ± 0.15	
	Distant communities	8	0	0.64 ± 1.6	-0.11 ± 0.51	17	3	3.2 ± 2.9	0.54 ± 0.44	

Table 4.1.2. (contd)

Radionuclide	Location Group[a]	2000 No. of Samples	2000 No. of Detections[b]	2000 Maximum[c] aCi/m³[f]	2000 Average[d] aCi/m³[f]	1995-1999 No. of Samples	1995-1999 No. of Detections[b]	1995-1999 Maximum[c] aCi/m³[f]	1995-1999 Average[d] aCi/m³[f]	Derived Concentration Guide[e] aCi/m³[f]
Uranium-234	Onsite	32	31	74 ± 18	16 ± 5.1	69	65	85 ± 21	24 ± 4.2	90,000
	Perimeter	16	16	140 ± 32	27 ± 16	32	32	66 ± 21	31 ± 5.1	
	Nearby communities	12	11	50 ± 18	20 ± 9.4	24	24	54 ± 17	28 ± 4.2	
	Distant communities	8	8	28 ± 19	15 ± 6.2	17	16	41 ± 15	20 ± 3.7	
Uranium-235	Onsite	32	3	2.6 ± 3.4	0.13 ± 0.38	69	13	3.7 ± 2.7	0.71 ± 0.26	100,000
	Perimeter	16	1	4.3 ± 4.7	0.69 ± 0.71	32	10	6.0 ± 6.0	1.6 ± 0.55	
	Nearby communities	12	0	2.2 ± 4.5	0.14 ± 0.78	24	7	6.2 ± 5.6	0.92 ± 0.63	
	Distant communities	8	0	7.0 ± 9.3	0.50 ± 1.9	17	0	6.2 ± 6.3	0.40 ± 0.79	
Uranium-238	Onsite	32	27	80 ± 20	14 ± 5.4	69	67	92 ± 27	22 ± 4.0	100,000
	Perimeter	16	15	140 ± 32	26 ± 17	32	32	59 ± 20	28 ± 4.7	
	Nearby communities	12	12	36 ± 15	18 ± 7.5	24	23	56 ± 18	25 ± 4.6	
	Distant communities	8	8	28 ± 10	13 ± 6.3	17	17	33 ± 15	19 ± 3.0	
Cobalt-60	Onsite	55	0	3,800 ± 2,500	89 ± 177	218	10	880 ± 490	62 ± 35	80,000,000
	Perimeter	40	0	520 ± 4,900	-124 ± 186	148	7	1,000 ± 530	43 ± 55	
	Nearby communities	33	0	1,800 ± 3,600	-97 ± 244	106	2	1,000 ± 960	28 ± 62	
	Distant communities	9	0	410 ± 950	48 ± 128	46	2	680 ± 440	140 ± 77	
Cesium-137	Onsite	55	0	540 ± 870	-29 ± 140	218	7	710 ± 530	18 ± 38	400,000,000
	Perimeter	40	0	1,200 ± 2,000	76 ± 140	148	2	670 ± 620	-17 ± 43	
	Nearby communities	33	0	2,100 ± 3,100	130 ± 180	106	2	860 ± 580	22 ± 48	
	Distant communities	9	0	370 ± 440	-43 ± 190	46	1	390 ± 290	18 ± 72	

(a) Location groups are identified in Table 4.1.1.
(b) Detection is defined as a value reported above the minimum detectable activity or above the 2-sigma total propagated analytical uncertainty. A detection for gamma-emitting radionuclides, cobalt-60 and cesium-137, is defined as a value above the minimum detectable activity.
(c) Maximum single sample result ± total propagated analytical uncertainty at 2-sigma. Negative concentration values are explained in Appendix A.
(d) Average of all samples ±2 times the standard error of the mean.
(e) DOE derived concentration guide (see Appendix D, Table D.5).
(f) There are 1 million attocuries (aCi) in 1 picocurie (pCi).
(g) One result from the distant communities was excluded as anomalous (5,530 ± 1,900 aCi/m³ at Yakima).

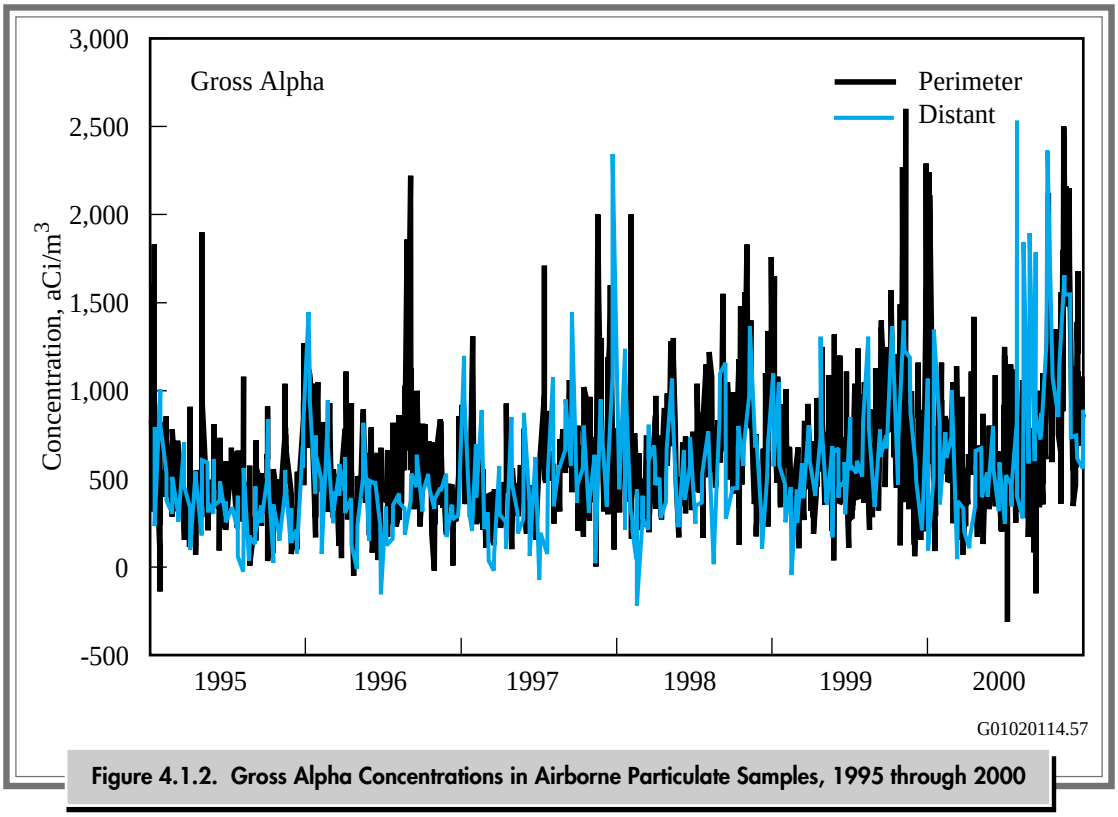

Figure 4.1.2. Gross Alpha Concentrations in Airborne Particulate Samples, 1995 through 2000

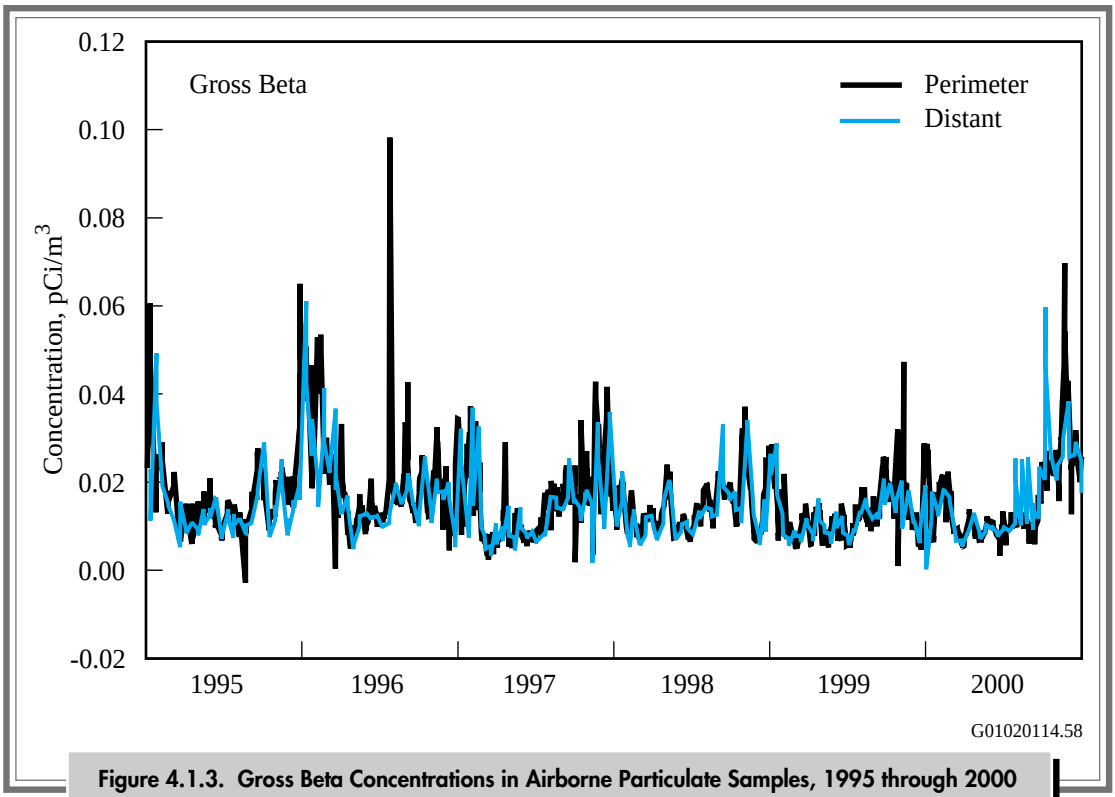

Figure 4.1.3. Gross Beta Concentrations in Airborne Particulate Samples, 1995 through 2000

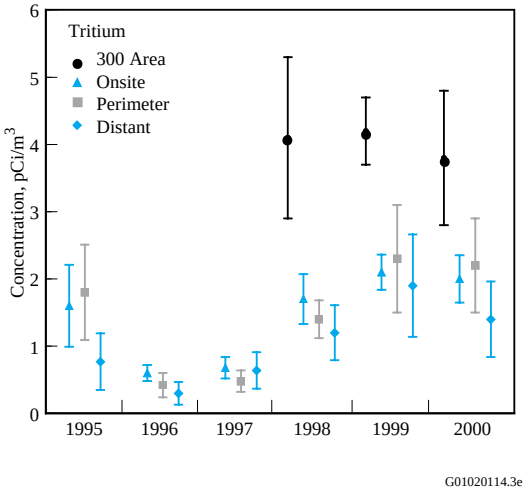

Figure 4.1.4. Annual Average Tritium Concentrations (±2 standard error of the mean) in Air, 1995 through 2000

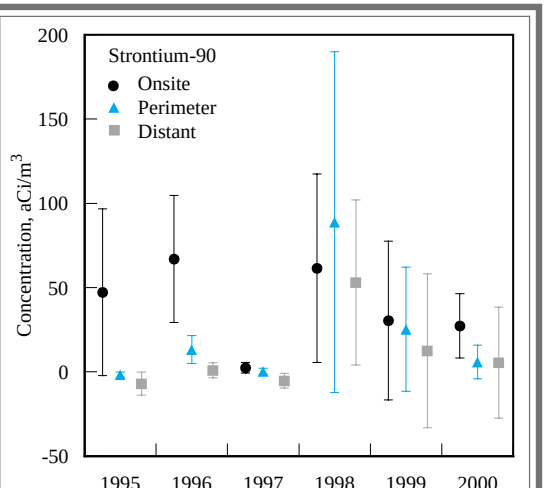

Figure 4.1.5. Annual Average Strontium-90 Concentrations (±2 standard error of the mean) in Air, 1995 through 2000 (1 pCi = 1,000,000 aCi)

Extraction Plant, at two downwind perimeter locations, and at a distant location (Yakima) in 2000 (see Figure 4.1.1). Onsite concentrations in 2000 were elevated compared to those measured at the site perimeter, and perimeter levels were higher than those measured at Yakima, the distant location (Figure 4.1.6 and see Table 4.1.2). Iodine-129 concentration differences between these locations were statistically significant (log transformed, two-tailed t-test, 5% significance level) and indicated a Hanford source. Onsite and perimeter air concentrations have remained at their respective levels from 1995 through 2000 (see Figure 4.1.6). Onsite air concentrations of iodine-129 were influenced by minor emissions (0.0012 curie; see Table 3.1.1) from the Plutonium-Uranium Extraction Plant and possible releases from waste storage tanks and cribs. The annual average iodine-129 concentration at the downwind perimeter in 2000 (0.60 ± 0.32 aCi/m^3) was less than 0.000001% of the 70 million-aCi/m^3 derived concentration guide.

Plutonium-238 was not detected in any samples for 2000 (nominal detection limit of 0.87 aCi/m^3). The annual average air concentration of plutonium-238 for all samples was less than zero (i.e., not detected).

The average plutonium-239/240 concentrations detected in onsite and offsite air samples are given in Table 4.1.2 and Figure 4.1.7. The annual average air concentration of plutonium-239/240 at the site perimeter was 0.48 ± 0.38 aCi/m^3, which is less than 0.003% of the 20,000-aCi/m^3 derived concentration guide. The annual average air concentration appeared to be higher for the site perimeter locations than the distant locations; however, the difference was not statistically significant (log transformed, two-tailed t-test, 5% significance level). The maximum Hanford Site plutonium-239/240 air concentration (6.4 ± 3.7 aCi/m^3) was observed for the 200 West composite sample (location 14 on Figure 4.1.1). This represents less than 0.04% of the 20,000-aCi/m^3 derived concentration guide.

Average isotopic uranium concentrations (uranium-234, -235, and -238) in airborne particulate matter in 2000 were similar on the site, at the site perimeter, and at distant communities (see Table 4.1.2 and Figure 4.1.8). The 2000 annual average uranium-238 concentration for the site perimeter was 26 ± 17 aCi/m^3, which is 0.03% of the 100,000-aCi/m^3 derived concentration guide.

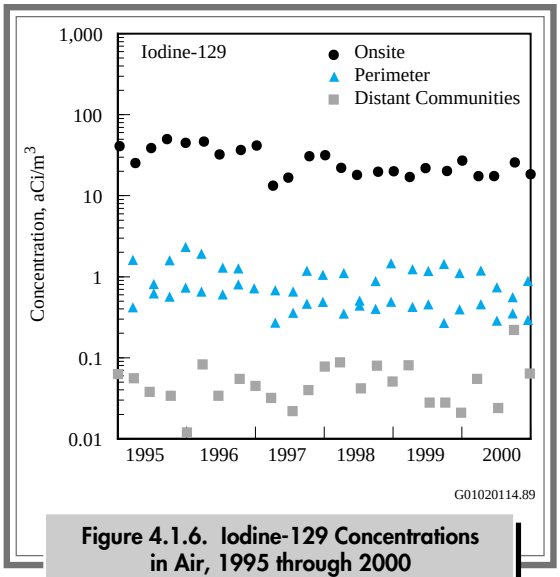

Figure 4.1.6. Iodine-129 Concentrations in Air, 1995 through 2000 (1 pCi = 1,000,000 aCi)

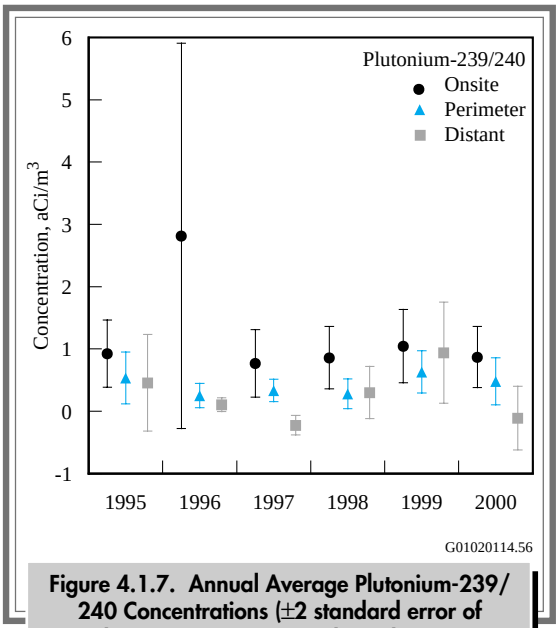

Figure 4.1.7. Annual Average Plutonium-239/240 Concentrations (±2 standard error of the mean) in Air, 1995 through 2000 (1 pCi = 1,000,000 aCi)

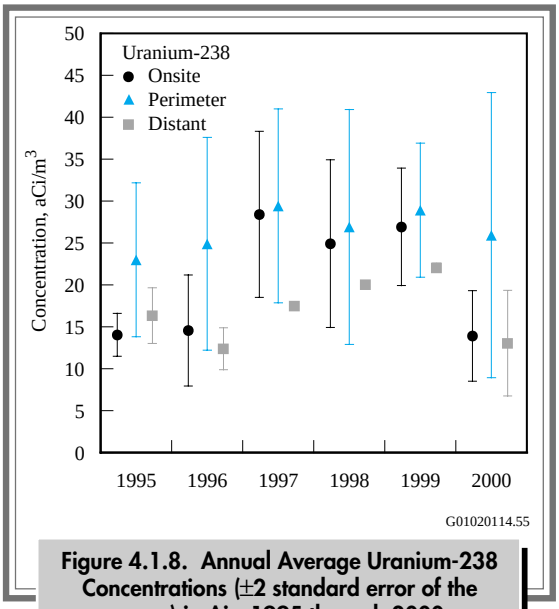

Figure 4.1.8. Annual Average Uranium-238 Concentrations (±2 standard error of the mean) in Air, 1995 through 2000 (1 pCi = 1,000,000 aCi)

Samples were analyzed quarterly by gamma spectroscopy. Naturally occurring beryllium-7 and potassium-40 were routinely identified. The potential Hanford-origin gamma-emitting radionuclides of cobalt-60 and cesium-137 associated with airborne particulate matter were monitored by gamma spectroscopy. Of the 137 samples analyzed by gamma spectroscopy, none of the samples had concentrations above the minimum detectable level for the sample for that isotope. The cobalt-60 and cesium-137 results for 2000 samples are included in Table 4.1.2. Even the maximum estimated individual measurements for these radionuclides (3,770 ± 2,500 and 2,060 ± 3,100 aCi/m^3, respectively) were less than 0.004% of their derived concentration guides.